United States Coast Guard Research & Development Center's Oil Spill Program

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Mission

To conduct research & development, and test and evaluation of existing and emerging Oil Spill Response Technologies.

Introduction

The Coast Guard's 'Spill Research and Development Program' has been underway for more than 30 years. While the majority of the efforts have focused on oil response, other hazardous materials response issues have also been investigated. The initial oil spill R&D efforts were triggered by two major oil spills: the 1968 TORREY CANYON grounding off the Coast of England and the 1969 well blowout off Santa Barbara, California. During the early and mid-1970s, initial efforts included development of the airborne oil spill surveillance system (AOSS), the air-deliverable anti-pollution transfer system (ADAPTS) for removing oil from damaged tankers, the fast-delivery sled system (FDSS) for rapidly transporting equipment to the spill, and the open water oil containment and recovery system (OWOCRS) for removing oil from the water in offshore environments.

The R&D program continued throughout the late 1970s and 1980s, expanding to address spill response challenges in offshore environments such as the extreme weather conditions encountered during the sinking of tanker ARGO MERCHANT off Nantucket in December 1976. During this time, Coast Guard R&D implemented a program to upgrade vessel damage assessment and offloading technology and further develop and test oil spill containment and recovery equipment. In addition, oil exploration and development activities along the coast of Alaska, particularly in the Beaufort Sea, pointed out the need for developing techniques applicable to ice-infested waters. During the 1980s a wide variety of projects were pursued for Arctic response. Development of systems and techniques for removing oil from ice-infested waters, technologies for detecting and mapping oil under ice, computer models for predicting the behavior and movement of oil spilled in the Arctic, and environmental atlases plus comprehensive field guides to support strategy development and response implementation. In the mid-1980s priority shifted to other demanding Coast Guard mission areas. The R&D oil spill program was scaled back, focused on assessing and documenting existing technology and providing the On-Scene Coordinator (OSC) with information and decision tools to effectively manage spill response.

On March 24,1989, the EXXON VALDEZ ran aground on Bligh Reef in Prince William Sound producing the largest oil spill in U.S. history. Several reports analyzed the EXXON VALDEZ spill and called for upgrades in oil spill response strategy and technology. Congress reacted with Title VII of the Oil Pollution Act of 1990 (OPA 90). The results of two workshops formed the basis for the Interagency Oil Spill R&D Plan that was subsequently mandated by Title VII of OPA 90. (http://www.uscg.mil/hq/g-m/nmc/gendoc/coop/coop.htm). The RDC set about devising oil spill R&D strategy for the 1990s. Major advancements have been in spill planning and management; spill surveillance, vessel salvage, onboard containment, cleanup, and alternative countermeasures. An investment of about $20 Million could potentially save over $1 Billion is response costs and damages. Details on the efforts performed since 1990 are contained in U.S. COAST GUARD, OIL SPILL RESPONSE RESEARCH & DEVELOPMENT PROGRAM, A DECADE OF ACHIEVEMENT. The original strategy and plan continued into the 21st century with further refocusing as performance gaps have been identified. Projects addressing In-situ Burning and Fast-Water Containment were completed in 2003 and more information is contained in the reports on this Internet site. Issues addressed for other hazardous materials included a response manual for combating floating hazardous materials, evaluation of techniques to test protective clothing, an analysis of the causes of chemical spills between 1970 and 1995, and a history of USCG hazardous materials management.

Post September 11, 2001, focus was redirected to spill response management concerning issues in the hazardous materials accidentally or intentionally released. The program currently focuses on several major areas: Hazardous Materials Spill Planning and Management, Group Five (Heavy) Oils and Use of Dispersants.

Spill Response Planning and Management

Thorough contingency planning, enhanced training, and rapid informed decision-making during catastrophic events spill response improve. Time is a critical factor; a delay in decisions jeopardizes mission effectiveness. Since major spills are rare, on the job involvement cannot satisfy the training needs. Spill response planning and training methods must be improved for local, regional, and national groups to ensure personnel are prepared in adequate numbers for major spill response.

The RDC has been investigating systems and technologies to facilitate deployment and management of equipment, personnel, and logistic resources during a major oil spill. Included was the development and demonstration of USCG recommended guidelines for effectively and efficiently presenting and distributing information within an Incident Command System (ICS) Command Post. Initial efforts focused on developing a method of graphically presenting charts and information to those managing the spill, versus posting charts on a corkboard. The conceptual system was given the name Multi-Agency Response, Tactical Action Display (MARTAD), and functional requirements were evaluated via promising, industry-developed systems. The experience gained from this evaluation was (a) used to develop USCG recommended guidelines for marine spill response, command-post display systems; and (b) factored back into the development process for the USCG OSC^2 system. The initial prototype of OSC^2 (OSC^2 Mod 1) was completed in 1997, and potential future system features and capabilities continue to be investigated. The functionality of OSC^2 is being incorporated into the web-based Marine Information for Safety and Law Enforcement (MISLE) application, which will be available via the USCG intranet to all USCG units.

The RDC is also involved in developing tools to support the upgrading of the planning implantation of oil spill response management exercises, and follow up evaluation. The Multi-Agency Training and Evaluation System (MATES) was developed and put into operation during the mid-1990s. Replacing MATES, the prototype Pollution Incident Simulation Control and Evaluation System (PISCES) was developed and field-tested at the NSF Coordination Center and Training Center Yorktown. Among other things, PISCES can track the assets deployed using the Global Positioning System (GPS) and transmit the data via very high frequency (VHF) radio transmission back to the exercise control center for display. Upgrades to this system, based upon field-testing conducted at several spill response exercises, are now underway.

The latest efforts are addressing additional hazardous materials other than oil. Since these spills are infrequent in most of the country, watch standers need help to identify hazards to personnel and the public quickly. Ongoing efforts include cooperation with NOAA to enhance the Computer-Aided Management of Emergency Operations (CAMEO) Suite of tools and evaluation of alternate software to identify, collect, and pass information needed to make quick and proper decisions. The enhanced HAZMAT modeling package will allow CG first responders to rapidly ascertain the movement and behavior of hazardous chemical and CBR spills allowing for quicker, effective decision making during first response operations.

Heavy Oil

Background

Petroleum in the heavy oil category can take several configurations during a spill. Some oil is heavier than water in its natural state and classified as a Group V product called low American Petroleum Institute gravity oils (LAPIO). These substances have a high specific gravity and may not float. There is also a type of oil called Orimulsion: slurry containing oily coal particles (Bitumen) that will sink depending upon the water density. The third type is weathered oil that loses the volatile components; it may absorb water (become an emulsion) and may sink enough so that it is not visible at the surface.

In 1999, the National Academy of Science published the results of a study "Spills of Non-Floating Oils, Risk and Response." One of the recommendations was for the Coast Guard to support the development of laser and sonar systems for tracking oil in the water column. In 2002, an international conference, International Maritime Organization (IMO) Forum on Heavy Oils, recommended that IMO, government and industry co-operate internationally in the development of laser and sonar systems for detecting high density oil spills. In addition, recommendations were also included to facilitate the testing of prototype systems and to validate the use of these sensors during actual spills.

The behavior of Orimulsion when spilled in water is very different from other Group V products and presents challenging response scenarios. A study was conducted to investigate the weathering characteristics of spilled Orimulsion as related to bitumen drop-size development. (http://www.rdc.uscg.gov/reports/1999/cgd2499i.pdf) The benefit will be a fundamental understanding of the unique physical behavior of Orimulsion. The results of this study will allow the USCG to better evaluate Orimulsion recovery systems and enhance recovery methods. The USCG, Canadian Coast Guard (CCG), and Bitor America have jointly funded a number of other projects in such areas as beach cleaning, skimmer systems, and living ocean resources.

Detection

In responding to any large spill, it is essential that the On-Scene Coordinator know the location, area coverage, and general physical condition of the oil to effectively deploy cleanup resources and protect environmentally sensitive areas. To provide this information, a 24-hour, all-weather surveillance capability is required. This program focuses on the development, test and evaluation, and implementation of an upgraded oil spill remote sensing capability for the USCG. An initial study a comprehensive study of the USCG mission requirements for airborne surveillance, and the technologies currently available was completed in 1997. This was followed by an in-house literature review of recent research and supported the development of advanced oil spill remote sensors. The USCG provided support for the Environment Canada project to develop a laser fluorosensor and laser thickness sensor. The laser fluorosensor focused on mapping and positively identifying hydrocarbons on the water and shoreline and reducing false identification problems encountered with other sensors. The laser thickness sensor seeks to accurately profile the thickness of an oil slick from the air to assist in locating heavier oil concentrations. These systems are still under development by EC. The RDC initiated an exploratory study to investigate and demonstrate the feasibility of developing a frequency-scanning microwave radiometer (FSR) for oil spill surveillance. This instrument would map the distribution of thicker oil in a slick. This work included development and concept validation testing of a prototype frequency scanning microwave radiometer for measuring oil slick thickness. Initial testing was successful, leading to a series of controlled measurements at the OHMSETT test tank in 1995 to determine how accurately oil thickness and degree of emulsification can be measured as a function of various sky/sea conditions, oil type, and thickness variations within the sensor beam. A report evaluating the potential of this concept for developing an operationally useful oil spill sensor was completed. The system was effective in calm water but achieved mixed results when tested with waves and emulsified oil.

The third approach to upgrading surveillance capabilities included test and evaluation of existing sensors. Sandia National Laboratories evaluated the performance of a state-of-the-art Synthetic Aperture Radar (SAR) against the existing Side Looking Airborne Radar (SLAR), currently installed on HC-130 aircraft. Test flights over the Santa Barbara oil seeps were completed and the data was submitted to USCG Headquarters for evaluation. Radar can be used if the wind is between about 4 knots and 25 knots, not above or below there can be a lot of false positives with radar. In addition, other existing USCG sensors were evaluated as opportunities allowed. Specifically, the HU-25B AIREYE UV/IR linescanner, a turret-mounted Forward-Looking InfraRed (FLIR)/video sensor package in the HU-25C aircraft, a turret-mounted FLIR on the HH-60J helicopter, and several hand held FLIRs. These tests provided a clearer picture of USCG oil spill surveillance capabilities for both spill response and enforcement. Other efforts centered on the use of hand-held infrared devices on helicopters for extending the surveillance capability at night

Due to the reduced amount of spills and the higher priority for security issues, sensors have not been utilized for oil spill response. Currently, some CG aircraft have FLIR that can track oil initially if the spill is a different temperature than the water, which usually is true at the beginning of a spill. There are side-looking radars (SLAR) on HC-130's at Elizabeth City but nothing on the Gulf or West Coasts. In general, visual sighting is the most reliable but cannot be used at night or in cloudy weather. During the April 2003 barge spill in Buzzards Bay, initial visual assessment was not an option, as most of the oil came ashore at night. A nighttime capability may have helped to identify that the spill was indeed larger than first suspected and earlier response efforts could have reduce the environmental and cost impact

Knowing the location and movement of oil patches at night and in cloudy weather will permit timely and efficient decision-making for the deployment of resources. This will decrease the impact on the environment and response costs. Although the technology is being designed for large open-ocean spills, it may have applications for detecting spills in coastal areas and harbors. Utilization of automated detection systems will also increase Coast Guard's Maritime Domain Awareness, by freeing up other CG assets while providing quicker detection of hazardous materials.

Dispersant Study

Dispersants can provide oil spill responders with a tool to fill the void during rough weather that precludes the use of mechanical recovery or in-situ burning. Spills during these circumstances amount to over 20% of spills 1,000 gallons or greater. Proposed regulations are expected in the next couple of years to include dispersants for use by Oil Spill Response Organizations (OSRO), thus more use of dispersants is expected. Agreement cannot be reached among stakeholders on the situations where chemical dispersants may prove useful in near-shore and far-offshore environments. Current techniques for evaluating the toxicity and effectiveness of dispersants are not consistent in the literature. Few full-scale trials have been performed providing valid scientific data needed to make decisions

The National Academy of Sciences (NAS) published its last report in 1989 that recommended the use of dispersant in offshore areas greater than 3 miles from shore. A new committee was convened in 2003 to evaluate the latest state-of-the-art and provide recommendations for future efforts and partially funded by RDC. Details can be found at:

http://dels.nas.edu/dispersants/index.html.

It is hoped that the resulting report will provide recommendations for guidelines for operational use of dispersants that address all stakeholder concerns, and identify further research needed to evaluate the safe use of dispersants for near-shore oil or large offshore blowout spills. Coast Guard R&D and other organizations to prioritize funding to close information and performance gaps with respect to the safety and efficiency of dispersants can use the recommendations. The results of research could provide changes in policies and procedures that improve response capabilities and have a positive net environmental benefit to the area affected.